PICTURE INPUTTING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

5   The present invention relates generally to a picture inputting apparatus for use in picture input to an animation processing system, etc., and more particularly to an image inputting apparatus using a high-resolution solid state

10   image pickup device to acquire low-resolution whole pictures and high-resolution partial pictures.

2. Description of the Related Art

Up until now, in order to acquire detailed

15   picture information while securing a wide range of observation range, picture inputting apparatuses have employed a method in which the resolutions are uniformly improved by raising the mounting density of image pickup devices such as

20   CCD image pickup devices or CMOS image pickup devices. The raised resolutions of the image pickup devices lead to securement of sufficient resolutions and to acquisition of detailed contents for a relatively small target as well

25   even though a wide-angle optical lens is used to shoot a wider area.

However, such a uniform raise of the

resolutions of the image pickup devices has disadvantageously resulted in enormous amount of information possessed by the pictures and in a lot of time required to transmit the pictures since

5   limitation is imposed on the capacities of the transmission path for transmitting the pictures and on the input capacities of the apparatuses for inputting pictures into the image processor or a display unit, thus leading to an extreme

10   lowering of the frame rate by which pictures can be obtained.

When using an image pickup device of e.g., 3000000 pixels of 1700×1700 pixels in length and width, the frame rate to be acquired is of the

15   order of 8 fps (frames per second). For this reason, if a high-resolution image pickup device is used for image pickup when the target is moving, it has been difficult to follow a target whose position varies with time and to use it as the

20   image inputting apparatus of the time-varying image processing system.

Proposed as the prior art for preventing such a lowering of the frame rate is a method for realizing the simultaneous acquisition of the

25   whole observation and the partial detailed pictures while suppressing the total amount of information, by acquiring, for the whole picture

of the target to be shot, pictures with reduced pixels through the lowering of the resolution and simultaneously by acquiring, for only a part of the wholeness, detailed pictures without

5 increasing the pixel count through the shooting of high-resolution pictures without lowering the resolution.

To realize this, there are roughly two approaches, first is an approach using a device,

10 and second is an approach using a plurality of image pickup sensors. The former is a method as proposed in Japanese Patent Laid-open (*kokai*) Pub. No. H9-214836. For shooting of the wholeness of the target, a high-resolution image pickup device

15 is used which consists of a plurality of photo-receptive cells (photo-receptive pixels) which are arranged at a high density, and the obtained high-resolution pictures are thinned out for accumulation into a memory in the form of a

20 low-resolution whole picture. On the contrary, for only a part of the whole picture, the original high-density picture information is extracted to accumulate it as a detailed picture into another memory, with the two pictures being extracted

25 switchingly every one frame or for each more than one frames such that the two pictures accumulated in their respective memories are synthesized into

a single picture, which in turn is output in NTSC format so that the picture can be monitored by the NTSC television monitor.

For the camera system using a high-resolution image pickup device, Japanese Patent Laid-open (*kokai*) Pub. No. 2000-32318 proposes a method for simultaneously acquiring a whole picture for field angle registration and a partial detailed picture for auto-focusing, for a picture within the same frame. The summary of the realization mean is as follows.

Each row of one frame picture is scanned in sequence. The rows required for only the low-resolution picture of the whole picture are subjected to thinning-out processing for each row and, for the rows requiring it, the results of execution of the thinning-out processing on the pixel columns within the rows are accumulated in a memory for thinned-out pictures.

In the rows to acquire a detailed picture, information on all pixels within the row is accumulated in another memory for detailed pictures without performing the thinning out processing. The thinning out processing in the row and column directions are effected on the partial pictures unsubjected to the thinning out processing accumulated in the memory for detailed

pictures, to synthesize the obtained thinned-out low-resolution pictures of the partial pictures and the low-resolution pictures of remaining portions obtained in the previous stage and

5   accumulated in the memory for thinned-out pictures, to thereby output a low-resolution whole picture.

As to the partial pictures lying in the memory for detailed pictures, original high-resolution pictures for the wholeness of the row are

10   accumulated, and hence portions required as the detailed pictures are extracted for the output as the partial detailed pictures.

The methods proposed in the Patent Documents 1 and 2 allows suppression of the amount of

15   information to be transferred as well as securement of the picture frame rate since the picture size of the whole picture and of the detailed pictures is sufficiently small in terms of the total resolution.

20   The inventors of the present application have proposed the following as the method using a plurality of image pickup sensors (Japanese Patent Application No. 2001-140925). This method obtains partial detailed pictures by dividing a

25   target projected image into two images by a bisecting optical system, reducing the wholeness of one image using a reducing optical system to

allow a single image pickup device to shoot a whole picture, and shooting a part of the other image enlarged by an enlarging optical system using another image pickup device.

5   The above method is characterized in that at that time, the position to shoot a partial image can move to any position in the whole picture by attaching the image pickup device onto a mechanism capable of varying the position on a plane such

10   as an XY stage. According to this method, it is possible to equivalently obtain 100 times higher resolution by shooting partial pictures among images whose sides are enlarged to 10 times. In addition, it is possible to restrict the amount

15   of information to the doubled VGA amount of information at most by setting the size of the image pickup device shooting the whole picture and the detailed pictures to the size, e.g., of the order of VGA (640×480 pixels).

20   However, the methods of Patent Documents 1 and 2 have been effected for the purpose of allowing a person to simply perform the field angle adjustment and focusing adjustment in the camera shooting system. The above methods are arranged

25   such that output is made so that synthesized pictures of the whole picture for field angle adjustment and the partial detailed pictures for

focusing adjustment appear at the same time in order to allow the person to perform visual adjustments by the NTSC television monitor or such that auto-focusing adjustment is made by detailed pictures of a certain portion while allowing the person to visually observe the whole picture at all times through the NTSC television monitor.

To this end, in the method of Japanese Patent Laid-open (*kokai*) Pub. No. H9-214836, the whole picture and the partial detailed pictures are embedded in a single NTSC picture (whose resolution is of the order of 512×480 pixels in length and width), and hence the resolutions possessed by the respective pictures become halved. Thus, it is essential for a person to intervene since the portions to be image picked up as detailed pictures must be predefined fixed portions or must be directly designated from the outside of the apparatus due to the lowered amount of information as well as due to independent outputs of the whole picture and the partial detailed pictures.

In the method of Japanese Patent Laid-open (*kokai*) Pub. No. 2000-32318, the low-resolution picture of the whole scene is merely converted by D/A conversion into analog television signals such as NTSC and is output for field angle verifications, whereas the partial detailed

pictures are not output to the outside which are merely used within the interior of the apparatus for auto adjustment of the focus distance. Moreover, the acquiring positions of the partial

5 detailed pictures are predetermined positions or portions designated by a person from the outside of the apparatus.

In case of considering it as a picture inputting apparatus in the time-varying image

10 processing system, it is necessary to input picture information which is sole input information as much as possible, i.e., to input detailed picture information in terms of the stabilization of the processing and a higher function. In view of this

15 point, it is impossible for the camera system which outputs the whole picture and the partial detailed pictures as a single picture to implement desired performances due to its lowered amount of information.

20 The time-varying image processing system treats scenes which move (vary) with time as processing targets and the required information also varies with time, whereupon it is necessary to automatically set points at which the detailed

25 information is acquired, depending on the contents appearing in the scene which varies with time.

In the conventional apparatuses of Patent

Documents 1 and 2, however, the positions to acquire the detailed pictures must manually be designated from the outside of the apparatus. Since the apparatuses do not have any function

5 for varying the position to acquire the detailed pictures depending on the picture information, it would be difficult to meet the requirements for the time-varying image processing system.

Otherwise, the conventional apparatuses

10 suffer another problem on means for creating the whole low-resolution pictures. The conventional apparatuses create the low-resolution picture by merely thinning out the high-resolution pictures. If pixels are thinned out such that the dimensions

15 of the low-resolution picture becomes 1/N of the dimensions of the original high-resolution pictures, the input picture information results in having a N-times higher frequency than the sampling rate since the frequency band possessed

20 by the pictures is unvaried in spite of lowering of the picture sampling frequency to 1/N.

For this reason, aliasing occur at high-frequency portions due to the sampling theorem, resulting in false pictures. If false

25 information is included in the pictures input to the time-varying image processing system, the system may experience mis-recognition and thus

abnormal actions. Since such aliasing-based false information cannot be removed in the latter processings, it is inevitable to remove the false information at the stage of conversion into the

5 low-resolution pictures.

In Japanese Patent Application No. 2001-140925, the image pickup device obtaining partial high-resolution picture is moved through mechanical operations by use of, e.g., an XY stage.

10 Due to the weight of the drive of the stage and to the weight of the image pickup device itself, however, it is difficult to keep a high moving speed enough to move from end to end of the picture within the frame rate (e.g., 1/30 sec), and

15 consequently, to acquire detailed pictures at quite different points for each frame rate.

If N frames are required to complete the shooting of any point, when the target is an object which moves at a high speed, the position of the

20 target will offset from the position designated to acquire a detailed picture due to the movement of the target during N frames. It is thus difficult to catch the target needing the detailed picture at the center of the detailed picture, and

25 disadvantageously in case of particularly high speed, the target may possibly deviate from the detailed picture. There arises also a problem

that it is impossible to shoot, while varying the shooting positions on a frame rate basis, targets to be shot scattering in a shooting range.

SUMMARY OF THE INVENTION

5   It is therefore the object of the present invention to provide a picture inputting apparatus capable of acquiring a low-resolution whole picture and high-resolution partial pictures at one time and at a high speed.

10   Fig. 1 is a diagram illustrating the principle of the present invention. The present invention provides a picture inputting apparatus comprising a solid state image pickup device having a high-resolution pixel array consisting of a

15 plurality of photo-receptive elements disposed at a high density for converting a formed image into a pixel value of an electric signal by photoelectric conversion; a low-resolution whole picture scanning unit which outputs

20 low-resolution whole picture data by reading out and scanning the wholeness of an imaging range with the resolution of the pixel array lowered; a high-resolution partial picture scanning unit which outputs high-resolution partial picture

25 data by partially reading out and scanning the imaging range with high-resolution of the pixel array kept; a switching unit which provides a

switching between the low-resolution whole
picture scanning unit and the high-resolution
partial picture scanning unit within a
predetermined frame period to thereby output in
5   sequence the low-resolution whole picture data
and the high-resolution partial image data at a
speed equal to or greater than the video rate (30
fps); and an image processing unit which
automatically determines the extracting position
10   of the high-resolution partial picture at the next
frame, based on the low-resolution whole picture
data output from the low-resolution whole picture
scanning unit, to thereby instruct the
high-resolution partial picture scanning unit on
15   the extracting position.

        Thus, according to the present invention,
the whole   scene is acquired as a low-resolution
picture and only the partial noted points are
acquired as detailed pictures, with the result
20   that even though an extremely high resolution is
used for the detailed pictures, when the two
pictures have the same size, it is possible to
restrict the absolute amount of information of
the two pictures to the amount for the two pictures
25   at most and to acquire the whole picture and the
detailed pictures at one time and rapidly at a
frame rate equal to or greater than the video rate.

When a wide range of scene is shot by a television camera having an ordinary NTSC (512 ×480 pixels) size or VGA (640×480 pixels) size for example, detailed information may not be

5 obtained due to the collapsed picture arising from the insufficient resolution. However, use of the present invention makes it possible through the use of the high-resolution image pickup device to obtain detailed picture information without

10 the pictures becoming collapsed since the points requiring detained information are shot with high resolution kept whereas the whole image is shot with the resolution lowered such as for example NTSC 512×480 pixels or VGA 640×480 pixels.

15 In addition, by providing the whole picture with a low-resolution and by restricting the picture region of the detailed picture to a certain portion, it is possible to suppress the size (the amount of information) of the two pictures

20 themselves and to restrain the imaging rate of the pictures from lowering due to the excessive amount of information to thereby obtain the pictures at a speed rate equal to or greater than the video rate.

25 The image processing unit included in the apparatus allows portions whose detailed pictures are to be acquired to automatically and rapidly

be selected depending on the contents of the whole picture.

At that time, the acquiring position of the detailed picture is varied through electrical control of the readout position of the pixel array without needing any mechanical operations, and the time required for the change of the acquiring position is defined by longer one, between the time required for the processing determining the shooting position of the detailed picture at the next frame which is performed in the image processing unit, and the time period (frame rate) taken to shoot the next frame.

Thus, by restricting the processing performed by the image processing unit to the frame rate or less, the points of the detailed picture to be shot at the next frame can be determined within the current frame, thus enabling quite different positions to be shot for each frame.

The present invention enables optimum pictures to be input to the time-varying image processing system. The time-varying image processing system has contradictory requirements such as requiring detailed pictures (information) of a target object if it exists while observing at all time a wide shooting range within which a relatively small target object moving

therethrough lies, requiring the acquisition of
the detailed pictures following the movement of
the object since the moving object is a target ,
and further needing to change with time the

5   acquiring positions of the detailed pictures while
shooting the object with a picture shooting rate
equal to or greater than the video rate. The
present invention is however applicable to such
time-varying image processing system in general.

10   The present invention may be applied also
as an image inputting apparatus which includes
a high-level of pre-processing in which the
low-resolution whole picture and the
high-resolution partial picture are treated as

15   input information for the different image
processing system which follows.

        Examples of such an image processing system
can include a physical distribution management
system for managing the deliveries by reading

20   characters described on a small piece of seal
adhered to the object with high-resolution partial
pictures while monitoring the objects flowing on
the conveyor with the low-resolution whole picture,
and a monitoring system for accumulating or image

25   identifying the detailed pictures of an invader
obtained as high-resolution partial pictures
while monitoring the presence or absence of the

invader into the region, to thereby issue a proper
warning depending on the target.

Otherwise, the present invention is
applicable also to a picture inputting apparatus
5   for use with an ultra-high-resolution still image
camera which obtains high-resolution partial
pictures at respective positions of the whole
shooting range and synthesizes those pictures to
create an ultra-high-resolution picture of the
10 whole shooting range.

The picture inputting apparatus of the
present invention further comprises a
low-resolution whole picture accumulation unit
which accumulates the low-resolution whole
15 picture data output as a result of readout scanning
of the pixel array; a whole picture data
transmission unit which reads out images
accumulated in the low-resolution whole picture
accumulation unit to shape the low-resolution
20 whole picture data into a single piece of picture
data in a predetermined format (NTSC, VGA, etc.,),
for the output to the outside; a high-resolution
partial picture accumulation unit 24 which
accumulates the high-resolution partial picture
25 data output as a result of the readout scanning
of the pixel array; and a partial picture data
transmission unit which reads out images

accumulated in the high-resolution partial
picture accumulation unit to shape the
high-resolution partial picture data into a single
piece of picture data in a predetermined format

5   (NTSC, VGA, etc.,), for the output to the outside.

Herein, the solid state image pickup device
includes a plurality of photo-receptive elements
which are two-dimensionally arranged in N_1 rows
and N_2 columns; a column selection line and a row

10   selection line which select individually the
plurality of photo-receptive elements to allow
output of a pixel value; two output lines disposed
at each of the plurality of photo-receptive
elements; and a plurality of filters which

15   calculate and output the sum or the mean value
by connecting to their respective inputs one output
lines of the photo-receptive elements on an n_1 rows
and n_2 columns pixel basis where n_1 and n_2 are
integers obtained by dividing high-resolution N_1

20   rows and N_2 columns by low-resolution m_1 rows and
m_2 columns, respectively, where the pixel count
of the N_1 rows and N_2 columns provides a
high-resolution picture while the pixel count of
m_1 rows and m_2 columns less than the pixel count

25   of the N_1 rows and N_2 columns provides a
low-resolution picture.

In this case, the low-resolution whole

picture scanning unit collectively selects the photo-receptive elements for each n_1 rows and n_2 columns for each of the plurality of filters and simultaneously allows filter outputs of m_1 rows

5   and m_2 columns to be output in the form of low-resolution whole picture signals, whereas the high-resolution partial picture scanning unit scans the photo-receptive elements in k_1 rows and k_2 columns which are designated as the extracting

10   position within the N_1 rows and N_2 columns to allow pixel values to be output as high-resolution partial picture signals from the other output lines.

In this manner, the readout scanning of the

15   low-resolution whole image is subjected for output to the local averaging processing where the pixel array is segmented into the length n_1 × width n_2 pixel regions for the input into filters to obtain the sum total or the means value of the pixel values

20   as a new pixel value, whereby it is possible to suppress aliasing in which the picture high-frequency components form false information in the low-resolution picture and to provide satisfactory pictures for the image processing.

25   In the present invention, the low-resolution whole picture may be created by pixel thinned-out processing. That is, the solid state image pickup

device includes a plurality of photo-receptive elements which are two-dimensionally arranged in N_1 rows and N_2 columns; and a column selection line and a row selection line which select individually 5 the plurality of photo-receptive elements to allow output of a pixel value, wherein the low-resolution whole picture scanning unit allows output of low-resolution whole picture signals while thinning out pixel values for each n_1 rows and n_2 10 columns where n_1 and n_2 are integers obtained respectively by dividing high-resolution N_1 rows and N_2 columns respectively by low-resolution m_1 rows and m_2 columns, where the pixel count of the N_1 rows and N_2 columns provides a high-resolution 15 picture while the pixel count of m_1 rows and m_2 columns less than the pixel count of the N_1 rows and N_2 columns provides a low-resolution picture, and wherein the high-resolution partial picture scanning unit scans the photo-receptive elements 20 in k_1 rows and k_2 columns which are designated as the extracting position within the N_1 rows and N_2 columns to allow pixel values to be output as high-resolution partial picture signals.

Although in this case, the thinning-out may 25 possibly cause aliasing in the low-resolution whole image, it can be coped with by restricting its use to the observation target whose picture

suffers relatively small variance and less aliasing.

The low-resolution whole picture scanning unit and the high-resolution partial picture scanning unit perform readout scanning such that the low-resolution whole picture and the high-resolution partial picture have the same pixel size. For example, the low-resolution whole picture scanning unit and the high-resolution partial picture scanning unit perform readout scanning such that the low-resolution whole picture and the high-resolution partial picture have the same pixel size which is expressed by a matrix of 512 ×480 pixels in NTSC, 768×576 pixels in PAL or 640 ×480 pixels in VGA.

In this case, even though the resolution of the high-resolution partial pictures for obtaining the detailed images is extremely high, the amount of information of two pictures is still equal to the amount of information for two frames of NTSC 512×480 pixels or VGA 640×480 pixels, thereby enabling the two pictures to be readout at one time and rapidly at a frame rate equal to or greater than the video rate of 30 fps.

Although an increased resolution does not lead to a variance in the amount of information,

there is a relationship that accordingly as the
resolution becomes higher, the size of the region
of the high-resolution partial picture occupying
in the low-resolution whole picture becomes

5   smaller.

The image processing unit includes, as an
example of the processing thereof, an object region
extraction unit which extracts a changed object
region and an unchanged non-object region based

10   on the difference of pixels between low-resolution
whole picture data of the current frame and
background picture data of the last frame; a
background picture updating unit which adds
the unchanged non-object region to the background

15   picture data, for updating; a noted position
detection unit which selects an undetected noted
object through the comparison of the object region
data with detected object data of the last frame,
to determine a noted position, the noted position

20   detection unit adding the selected noted object
to the detected object data, for updating; and
an extracting position determination unit which
predicts a noted position of the next frame based
on a motion model obtained from the frame history

25   of the noted position of the selected noted object,
to determine a picture extracting position of the
next frame.

This allows acquisition of a high-resolution
picture of only the required position while
automatically tracking a moving object.

The image processing unit may automatically
5 determine the extracting position of a
high-resolution picture at the next frame based
on the high-resolution partial picture data in
addition to the low-resolution whole picture data
and instruct the high-resolution partial picture
10 scanning unit on the determined extracting
position.

More specifically, the image processing unit
includes an object region extraction unit which
extracts a changed object region and an unchanged
15 non-object region based on the difference of pixels
between low-resolution whole picture data of the
current frame and background picture data of the
last frame; a background picture updating unit
which adds the unchanged non-object region to the
20 background picture data, for updating; a
prediction failure detection unit which compares
high-resolution partial picture data acquired at
the current frame with low-resolution whole
picture data at the extracting position
25 accumulated in the last frame, the prediction
failure detection unit if the two pictures differs
from each other, removing the noted object from

the detected object picture of the last frame; a noted position detection unit which selects an undetected noted object through the comparison of the object region data with the detected object

5   picture data, to determine a noted position, the noted position detection unit adding the selected object to the detected object picture data, for updating; and an extracting position determination unit which predicts a noted position

10   of the next frame based on a motion model obtained from the frame history of the selected noted object, to determine the extracting position of the next frame.

Thus, in cases where there is no noted object

15   in the high-resolution partial picture at the position predicted and extracted with differing from the low-resolution partial picture at the extracting position accumulated in the last frame, the noted object in the detected object image is

20   removed so that the high-resolution partial picture of the noted object can again be acquired, to thereby recover the prediction failure.

The image processing unit determines the extracting position of a high-resolution partial

25   picture based on the execution of an image processing program externally loaded and retained or on an external instruction.

The picture inputting apparatus of the present invention further comprises a picture transmission unit which converts into analog picture signals low-resolution whole picture data

5 output from the low-resolution whole picture scanning unit and high-resolution partial picture data output from the high-resolution partial picture scanning unit, to transmit the obtained analog picture signals to an external image

10 processor via a transmission path. Herein, the picture transmission unit converts the low-resolution whole picture data and the high-resolution partial picture data into analog picture signals, respectively, for parallel

15 transmission.

Thus, by converting the low-resolution whole picture data and the high-resolution partial picture data into analog picture signals, respectively, for transmission, any processing

20 such as image recognition can be implemented on the basis of the low-resolution whole picture and the high-resolution partial pictures through the utilization of an external image processor disposed at a remote site.

25 The above and other objects, aspects, features and advantages of the present invention will become more apparent from the following

detailed description when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram of a first embodiment
5   of the present invention;

Fig. 2 is an explanatory diagram of a solid state image pickup device of Fig. 1;

Fig. 3 is an explanatory diagram of a photo-receptive cell disposed in a pixel array;

10   Fig. 4 is an explanatory diagram of photo-receptive cells and a filter for generating low-resolution picture pixel signal;

Fig. 5 is an explanatory diagram of photo-receptive cells for high resolution and of
15   group cells for low resolution;

Fig. 6 is an explanatory diagram of a two-dimensional arrangement of group cells for low resolution pictures which are grouped on filter-by-filter basis;

20   Figs. 7A to 7C are explanatory diagrams showing the relationship among pixel array size, low-resolution pixel size and high-resolution partial pixel size in the present invention;

Fig. 8 is a timing chart of readout scanning
25   for outputting low-resolution whole picture signals in the present invention;

Fig. 9 is a timing chart of readout scanning

for outputting high-resolution partial picture signals in the present invention;

Fig. 10 is an explanatory diagram of readout scanning timing of a low-resolution whole picture and a high-resolution partial picture for each frame period in the present invention;

Fig. 11 is an explanatory diagram of the status of observation effected by a picture inputting apparatus of the present invention;

Fig. 12 is an explanatory diagram of a low-resolution whole picture and a target object high-resolution partial picture, obtained by the observation of Fig. 11;

Fig. 13 is a block diagram of a functional configuration of an image processing unit of Fig. 1;

Figs. 14A to 14D are explanatory diagrams of moving object processing in Fig. 13;

Figs. 15A to 15E are explanatory diagrams of undetected object extraction processing in Fig. 13;

Figs. 16A and 16B are flowcharts of image processing of Fig. 11;

Fig. 17 is a block diagram of a second embodiment of the present invention using a high-brightness partial picture for picture extraction processing;

Fig. 18 is a block diagram of a functional configuration of an image processing unit of Fig. 17;

Figs. 19A and 19B are flowcharts of image processing of Fig. 17;

Fig. 20 is a flowchart of prediction failure detection processing of Figs. 19A and 19B;

Figs. 21A and 21B are block diagrams of a third embodiment of the present invention in which picture signals are transmitted for processing to an external image processor;

Fig. 22 is an explanatory diagram of a solid state image pickup device for use in a fourth embodiment of the present invention in which low-resolution whole pictures are generated by pixel thinned-out scanning; and

Fig. 23 is an explanatory diagram of a photo-receptive cell disposed in a pixel array of Fig. 22.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1 is a block diagram of an embodiment of an image inputting apparatus according to the present invention. In Fig. 1, the image inputting apparatus of the present invention comprises a solid state image pickup device 10 having a pixel array 12, a low-resolution whole picture scanning unit 14, a high-resolution partial picture

scanning unit 16, a timing generation unit 18,
a switching unit 20, switches 22-1, 22-2,
low-resolution whole picture accommodation unit
24, a whole picture data transmission unit 26,
5   a high-resolution partial picture accumulation
unit 28, a partial picture data transmission unit
30, a picture extraction processing unit 32, and
an image processing program retention unit 34.

The pixel array 12 of the solid state image
10 pickup device 10 consists of a plurality of
photo-receptive elements (photo-receptive cells)
capable of obtaining high resolutions which are
two-dimensionally arranged at a high density and
serves to convert an image formed via an optical
15 system into a pixel value of an electric signal
through photoelectric conversion of the
photo-receptive elements.

At the timing when the switches 22-1 and 22-2
are switched to the shown position a by the
20 switching unit 20, the low-resolution whole
picture scanning unit 14 outputs, based on a timing
clock from the timing generation unit 18,
low-resolution whole picture data to the
low-resolution whole picture accumulation unit
25 24 which uses an accumulation memory, for
accumulation, through readout scanning of the
overall shooting range with reduced resolution

in the pixel array 12.

At the timing when the switches 22-1 and 22-2 are switched to the shown position b by the switching unit 20, the high-resolution partial picture scanning unit 16 outputs, based on a timing clock from the timing generation unit 18, high-resolution partial picture data to the high-resolution partial picture accumulation unit 28 which uses an accumulation memory, for accumulation, through partial readout scanning of the shooting range with retained resolution in the pixel array 12 designated by the image extraction processing unit 32.

The switching unit 20 provides in a frame period a switching between the low-resolution whole picture scanning unit 14 and the high-resolution partial picture scanning unit 16 and outputs the low-resolution whole picture data and the high-resolution partial picture data in sequence.

The image processing unit 32 automatically determines a position to extract the high-resolution picture in the next frame, based on the low-resolution whole picture data output from the pixel array 12 and accumulated in the low-resolution whole picture accumulation unit 24 through the readout scanning of the

low-resolution whole picture scanning unit 14,
and instructs the high-resolution partial picture
scanning unit 16 on the result of determination.

Associated with the image processing unit
5   32 is the image processing program retention unit
34 in which one or a plurality of image processing
programs are loaded and retained such that the
image processing programs required thereamong are
introduced into the image extraction processing
10   unit 32 and that the position to extract the
high-resolution partial picture is automatically
determined based on the low-resolution whole
picture.

The image processing unit 32 outputs the
15   result of processing of the image extraction
position to the outside and receives the
instruction of the image extraction position from
the outside so as to be able to transmit the external
instruction to the high-resolution partial
20   picture scanning unit 16 prior to the image
processing program.

The whole picture data transmission unit 26
and the partial picture data transmission unit
30 read picture data accumulated respectively in
25   the low-resolution picture accumulation unit 24
and the high-resolution picture accumulation unit
28 to arrange them into NTSC format or VGA format,

for later outputs, so that they can be observed with a video monitor, etc., or that as will be made clearer in the later description, picture data can be transmitted to the image processing

5   system disposed at a remote position by use of the picture transmission unit.

Fig. 2 is an explanatory diagram of the solid state image pickup device 10 of Fig. 1. In Fig. 2, the pixel array 12 consists of $N_1 \times N_2$ matrix of

10   pixels of photo-receptive elements for carrying out the photoelectric conversion which are two-dimensionally arranged, with each photo-receptive element converting the optical intensity into an electric signal at respective

15   positions of optical images condensed through optical lenses.

Associated with the pixel array 12 are a line selection circuit 36 and a column selection circuit 38 which are able to selectively readout any pixels

20   among the pixel array 12 depending on a line addressing signal 44 and a column addressing signal 46, respectively.

Toward the output of the pixel array 14 are a filter circuit unit 40 for issuing a

25   low-resolution whole picture signal, a pixel voltage output circuit unit 42 for issuing a high-resolution partial picture signal, and an

A/D converter 45 for converting a filter output
voltage or a pixel output voltage into digital
data.

Fig. 3 shows, in an exclusive manner, one
5   of the photo-receptive cells (photo-receptive
pixels) of the pixel array 12 of Fig. 2. In Fig.
3, associated with a photo-receptive cell 52 are
a row selection line 54 for selecting a row and
a column selection line 56 for selecting a column,
10   as well as two output lines 58 and 60 for
photoelectrically converting lights input by
the photo-receptive cell 54 into a voltage level
for output.

The output line 58 from the photo-receptive
15   line 52 is an output line to the filter for
generating a low-resolution whole picture signal,
whilst the output line 60 is an output line for
individual readout for generating a
high-resolution partial picture signal.

20   Fig. 4 shows one filter of the filter circuit
unit 40 for generating a low-resolution whole
picture signal provided toward the output of the
pixel array 12 of Fig. 2, and a photo-receptive
cell corresponding thereto. In Fig. 4, allocated
25   to the filer 62-11 are 3×3 matrix of total nine
(9) photo-receptive cells 52-11 to 52-33, from
each of which the same output line 58 as the case

of the photo-receptive cell 52 of Fig. 3 is input
to the filter 62-11.

The nine (9) photo-receptive cells 52-11 to
52-33 impart addressing signals at one time to
5   the three row selection lines and the three column
selection lines to thereby allow their respective
pixel voltages to be read at one time for input
into the filter 62-11. The filter 62-11 serves
to find out and output a sum or a mean value of
10   the input pixel voltages, and in this example,
it provides the mean value as its output.

Finding out the mean value (or the sum) of
the plurality of photo-receptive cells 52-11 to
52-33 by the filter 62-11 means lowering the
15   spatial resolution in the pixel array. In this
example,
3×3 matrix of pixels are grouped into one group
cell whose mean value is output from the filter
62-11, and hence the spatial resolution is lowered
20   to (1/3) × (1/3).

Fig. 5 is an explanatory diagram of
two-dimensional arrangement of the group cell for
a low-resolution picture which consists of the
filter of Fig. 4 and the nine (9) photo-receptive
25   cells, showing by way of example 6×6 matrix of
pixels at the upper left in the pixel array 12
of Fig. 2. When expressing one group cell by Sij,

i in the row direction and j in the column direction, four group cells can be expressed as group cells S11, S12, S21 and S22.

Associated with each cell are row selection
5   lines 54-1 to 54-9 and column selection lines 56-1 to 56-9. When obtaining low-resolution pixel outputs from the filter by reading out on a group cell by group cell S11 to S22 basis, addressing signals are fed at one time to the three row
10   selection lines and the three column selection lines for specifying nine (9) photo-receptive cells in each group cell S11 to S22 so that pixel voltages are read from the nine (9) photo-receptive cells of the selected group cell and input to the
15   filter so that the mean voltage (or sum voltage) of the pixel voltages is output as the low-resolution pixel value.

Fig. 6 shows the portions of the group cells S1 to S44 of the pixel array 12 when reading the
20   low-resolution picture signal. The addressing signals are fed every three lines of the row selection lines 54-1 to 54-12 and the column selection lines 56-1 to 56-12 for the group cells S11 to S44 so that readout with any group cell
25   designated can be achieved.

On the contrary, in case of reading out the high-resolution picture signals, addressing

signals are fed for each one of the row selection
lines 54-1 to 54-9 and the column selection lines
56-1 to 56-9 of Fig. 5 so that the high-resolution
picture signals can be readout with any

5 photo-receptive cells selected.

Figs. 7A to 7C show the relationship among
the array size of the pixel array 12 of Fig. 2,
the low-resolution pixel size and the
high-resolution partial pixel size. Fig. 7A

10 shows the array size of the actual photo-receptive
cell in the pixel array 12, having the pixel size
of $N_1 \times N_2$ pixels in matrix.

In case of generating a low-resolution whole
image region 64 having a small size matrix $m_1 \times$

15 m_2 as shown in Fig. 7C, e.g., of 512×480 pixels
in matrix of NTSC or of 640×480 pixels in matrix
of VGA through the readout scanning of the pixel
array 12 having the pixel size of $N_1 \times N_2$ pixels in
matrix with the resolution lowered, $n_1 \times n_2$ matrix

20 of group cell region 63 is defined as shown in
Fig. 7B, which in turn is allocated to the group
cells S11 to SN_1N_2 of the pixel array 12 as shown
in Fig. 7A.

The following relations are established

25 among the pixel sizes of the pixel array 12, the
group cell 62 and the low-resolution whole image
region 64.

$$m_1 = \lfloor N_1 / n_1 \rfloor$$
$$m_2 = \lfloor N_2 / n_2 \rfloor$$

where $\lfloor \ \rfloor$ denotes rounding off decimals to make integers.

5   By finding out the mean value (or the sum) through the input connection by the output line 58 from the photo-receptive cell to one filter as shown in Fig. 4 for each group cell 62 having a matrix of $n_1 \times n_2$ size, the high-resolution pixel

10   region of $N_1 \times N_2$ in matrix of the pixel array 12 of Fig. 7A can be made with reduced resolution into the low-resolution whole image region 64 of a matrix of $m_1 \times m_2$ size as shown in Fig. 7C.

      Through the local averaging processing in

15   which with the plurality of photo-receptive cells making up the group cell, the means value or the sum is found out by the filter for the output in the form of pixel values with lowered resolution, it is possible to suppress the aliasing by which

20   picture high-frequency components form false information in the low-resolution picture and consequently to obtain a satisfactory low-resolution whole picture for the image processing.

25   Further, shown in the pixel array 12 of Fig. 7A is an extraction region 65 of the high-resolution partial picture designated by the

high-resolution partial picture scanning unit 16
under the image processing unit 32 of Fig. 1. The
extraction region 65 is of the pixel size of k_1
$\times k_2$ in matrix, this $k_1 \times k_2$ pixel size being

5   basically equal to the size of the low-resolution
whole image region 64 of Fig. 7C.

If for example the low-resolution whole image
region 64 is of 512×480 pixels in NTSC matrix or
of 640×480 pixels in VGA matrix, then $k1 \times k2$ matrix

10   of pixel size of the extraction region 65 of the
high-resolution partial picture must be equal to
the NTSC matrix of 512×480 pixels or to the VGA
matrix of 640×480 pixels.

It is natural that the $k_1 \times k_2$ matrix of pixel

15   size in the extraction region 65 of the
high-resolution partial picture is not limited
to the same size as the low-resolution whole
picture region 64 but could be arbitrarily set
depending on the size of the noted portion of the

20   noted object whose detailed images are actually
desired to be obtained on the condition that the
readout operation is performed at a rate greater
than the video rate.

Fig. 8 partially shows a timing chart of the

25   readout scanning of the low-resolution whole
picture signal in the pixel array 12 of Fig. 2.
In Fig. 8, three-by-three column addressing

signals C1 to C3, C4 to C6, and C7 to C9 are simultaneously fed at the timings of times t1, t2 and t3, and correspondingly thereto row addressing signals L1, L2 and L3 are successively

5   fed from the time t1, whereby nine (9) photo-receptive cells are simultaneously designated at each of the times t1 to t3 so that the pixel voltages are read at one time into the corresponding filters for each group cell so as

10   to output the averaged pixel voltage from the filter.

Fig. 9 shows a part of the timing chart of the readout scanning of the extraction region 65 resulting in the high-resolution portion of Fig.

15   7A.

In Fig. 9, with a row addressing signal L_i corresponding to the leading address at the image extraction position being output at the time t1, column addressing signals C_j to C_{j+k2} are output

20   in sequence and readout on a reception basis from the same time t_1, after which a row addressing signal L_{i+1} for the next row is fed at the time t3 and then the sequential outputs of the column addressing signals C_j to C_{j+k2} are similarly

25   repeated. These operations are repeated until the row addressing signal reaches L_{i+k1} (not shown).

Fig. 10 is an explanatory diagram of the

timing to readout and scan the low-resolution whole picture and the high-resolution partial picture for each frame period by the switching unit 20 of Fig. 1.

5   In Fig. 10, when taking notice of the timing in the frame period resulting in 1/30 sec at the video rate, an exposure to light (pixel value accumulation) 66-1 is performed during the first period of time T1 in which optical images input 10 through the lens system are received by the arrayed cells of the pixel array 12 and electric charges are accumulated through the photoelectric conversion.

      Simultaneously with the completion of this 15 exposure to light 66-1, the switch 22-1 is switched to the low-resolution whole picture scanning unit 14 while simultaneously the switch 22-1 also performs the scanning selection 68-1 for switching to the low-resolution whole picture accumulation 20 unit 24. This allows a circuit system for reading out and scanning the low-resolution whole picture to be established.

      Then, through the readout scanning for each group cell of $n_1 \times n_2$ size whose input is connected 25 for each filter by the scanning signals from the low-resolution whole picture scanning unit 14 during the period of time T3, the low-resolution

whole picture signal is output from the pixel array 12 and is converted into digital data, which in turn is accumulated in the low-resolution whole picture accumulation unit 24.

5   Then, at the timing of T4, the switch 22-1 is switched to the high-resolution partial picture scanning unit 16, while simultaneously a scanning selection 72-1 is carried out in which the switch 22-2 is switched to the high-resolution partial

10   picture accumulation unit 28.

Then, over the next period of time T5, the photo-receptive cell based readout scanning is performed of the extraction region of the high-resolution partial picture of pixel size of

15     $k_1 \times k_2$ in matrix designated by the image processing unit 32 in response to the row and column addressing signals from the high-resolution partial picture scanning unit 16, to thereby issue a high-resolution partial picture signal which in

20   turn is converted into digital data by an A/D converter and then accumulated in the high-resolution partial picture accommodation unit 28.

The next frame similarly experiences the

25   exposure to light 66-2, the scanning selection 68-2, the low-resolution whole picture readout 70-1 (not shown) and the high-resolution partial

picture readout 70-2 (not shown) in a repetitive manner. During the next frame, the picture data retained in the low-resolution whole picture accumulation unit 24 and the high-resolution

5   partial picture accumulation unit 28 in the previous frame is subjected to the shaping required for a single piece of picture data in a predetermined format in the whole picture data transmission unit 26 and the partial picture data

10 transmission unit 30, respectively, and then is output as the low-resolution whole picture data and the high-resolution partial picture data to the outside.

During the frame period in which are carried

15 out the exposure to light, scanning selection, low-resolution whole picture readout, scanning selection and high-resolution partial picture readout, the image processing unit 32 determines the extraction position of the high-resolution

20 partial picture on the basis of the low-resolution whole picture data in the previous frame accumulated in the low-resolution whole picture accumulation unit 24, and instructs the high-resolution partial picture scanning unit 16

25 on the extraction position in the next frame.

Although in this embodiment, the image processing unit determines the picture extraction

position of the high-resolution partial picture based on the low-resolution whole picture data of the previous frame in accordance with the image processing program, image extraction mode by the

5   external instruction may be selected in order to ensure the acquisition of the high-resolution partial picture at the externally designated extraction position.

Selection of this external instruction mode

10   enables a high-resolution partial picture at the externally designated position to be acquired prior to the image processing program when the image processing unit 32 externally receives an instruction signal indicative of the image

15   extraction position. Naturally, when the externally instructed mode is turned off, the external instruction signal is ignored so as to be able to automatically designate the extraction position of the high-resolution partial picture

20   based on the image processing program.

Description will then be made of processing for acquiring the detailed pictures of a plurality of objects as noted objects which move over a wide range, the processing is a process to acquire the

25   high-resolution partial picture by the image processing unit 32 provided in the image inputting apparatus of Fig. 1.

Such a processing for acquiring the detailed pictures as the high-resolution partial picture in the image processing unit 32 allows any processes other than tracking the moving object.

5 The contents of the image processing depend on the image processing program retained in the image processing program retention unit 34 and therefore this description is a mere example of the possible image processing programs.

10 Fig. 11 is an explanatory diagram of the status of observation by the picture inputting apparatus of the present invention , for acquiring the detailed pictures of a plurality of objects moving over a wide range. The picture inputting

15 apparatus of the present invention generally designated at 100 is located at an appropriate position capable of capturing a plurality of moving objects within the picture range, the apparatus shooting for example a site over which objects

20 95 and 96 travel back and forth. In this case, the object 95 moves toward a motion vector 95-1 whilst the object 96 moves toward a motion vector 96-1.

At that time, it is possible for the picture

25 inputting apparatus 100 of the present invention to acquire a low-resolution whole picture 98 as shown in Fig. 12, and simultaneously to acquire

a high-resolution partial picture 104 of a set noted portion 105 of the moving object 95 in the low-resolution whole picture 98 so as to acquire detailed picture, e.g., a character picture of

5   the noted portion 105 at the extremity of the object 95.

The object of the low-resolution whole picture 98 acquired by the picture inputting apparatus 100 of the present invention is to make

10   judgment of the place where the object lies within the wide range of monitoring and judgment of the existence or absence of the noted portion to be acquired as a high-resolution portion picture, which has a feature capable of widening the space

15   shot by a single picture inputting apparatus 100 due to its wide range shooting.

The high-resolution partial picture 104 is a detailed picture of a noted portion obtained by selecting only the noted portion, which has

20   a feature capable of capturing without exception, e.g., even character information which may collapse when the wholeness is only viewed due to insufficient resolution.

By setting the image sizes of the two pictures,

25   i.e., the low-resolution whole picture 98 and the high-resolution partial picture 104 to be 640×480 pixels in VGA matrix, it is possible to acquire

two pictures at a high rate equal to or greater than the video rate of 30 fps and to cope with the moving objects whose positions vary with time. The picture inputting apparatus 100 of the present

5   invention is characterized in that it is capable of specifying the positions of all the objects even when a plurality of objects travel back and forth since it can capture the whole picture at all times.

10   Fig. 13 is a block diagram of image processing function implemented by a processing program for acquiring detailed pictures of the noted portions of a plurality of objects which move over a wide range.

15   In Fig. 13, the image processing unit 32 comprises as its image processing program function an object region extraction unit 76, a noted position calculation unit 80, a background picture updating unit 82 and an extracting position

20   prediction determining unit 84, as well as a background picture database 78 and a detected object picture database 84 acting as databases storing the required amount of data for the processing.

25   The object region extraction unit 76 inputs low-resolution whole picture data 86 and detects as an object region a site where the pixel value

undergoes a change in excess of a certain value
from the difference between the input
low-resolution whole picture data 86 and the
background picture data stored in the background
5   picture database 78 after updating in the previous
frame.   After the acquisition of this object
region picture, the object region extraction unit
76 calculates the position of the object by
extracting the mass of the image regions from the
10   object region image and sends an object portion
picture 88 to the noted position calculation unit
80.

The noted position calculation unit 80
determines an object to be shot in the next frame
15   and a noted position of the object in the picture
from the region information of a plurality of
objects by the object portion picture 88 input.
Utilized for the detection of this noted position
is detected object picture data retained in the
20   detected object picture database 85 and updated
in the previous frame.

On the basis of the position of the noted
point in the image based on the noted position
data 92 obtained by the noted position calculation
25   unit 80 as well as the motion information of that
object obtained as a result of observations in
the preceding frames, the extraction position

prediction determining unit 84 predicts the position in the next frame, determines the extraction position of an image whose high-resolution partial picture is to be obtained

5 in the next frame, and outputs extraction position information 94 to a high-resolution partial picture operation unit 16 of Fig. 1.

The background picture updating unit 82 updates a corresponding pixel in the background

10 picture of the previous frame accumulated in the background picture database 78 based on the background picture data 90 obtained by the object region extraction unit 76, to prepare for the detection of a moving object in frames which

15 follow.

Processings effected by the image processing unit 32 of Fig. 13 will then specifically be described with reference to Figs. 14A to 14D and Figs. 15A to 15E.

20 First, assume that the object region extraction unit 76 of Fig. 13 inputs an input picture 106 in the form of the low-resolution whole picture as in Fig. 14A for example. In the input picture 106 there exist objects 114 and 116, in

25 front of which other objects 118 and 120 exist.

At that time, assume that the background picture database 78 retains a background picture

108 as in Fig. 14B. That is, there exist the objects 114 and 116 in the background picture 108. Thus, the object picture extraction unit 76 figures out the difference between pixel values of pixels

5 of the input picture 106 and the background picture 108, compares in magnitude the value of the difference with a predetermined threshold value, labels pixels not less than the threshold value as the pixels of the moving objects, and

10 differently labels pixels less than the threshold value as the pixels of non-moving objects.

In this case, the operation FD implementation method for obtaining the difference between the pixel values can optionally be employed, without

15 specifically being limited, depending on whether the image is of a monochrome or color and on the use. When the image is of monochrome for example,

$$FD(I1^{(x1,y1)}, I2^{(x2,y2)}) = \left| I1^{(x1,y1)} - I2^{(x2,y2)} \right|$$

where $I1^{(x1,y1)}$ represents pixels values of

20 coordinates X_1, y_1 of an input image, and $I1^{(x2,y2)}$ represents pixel values of coordinates X_2, y_2 of the input image,

is used to find out the difference between the pixel values.

25 As a result of such processing of the object region extraction unit 76, an object portion picture 110 as in Fig. 14C and a background portion

picture 112 as in Fig. 14D are generated and the object portion picture 110 is output to the noted position calculation unit 80 and the background portion picture 112 is output to the background
5   picture updating unit 82.

In this case, the object portion picture 110 contains new objects 118 and 120 which do not exist in the background picture 108, whereas the background portion picture 112 is a picture
10   obtained by deleting the objects 118 and 120 in the object portion picture 110 from the input . picture 106.

Next, the noted position calculation unit 80 inputs the object partial picture data 88 from
15   the object region extraction unit 76 and creates object label images differently labeled for each mass indicative of an object. That is, since the object partial picture data 88 from the object region extraction unit 76 is an object point image
20   in which a label indicative of an object is affixed to a pixel indicative of an object portion, the noted position calculation unit 80 checks the type of the pixel to which the object label is affixed, extracts the mass resulting from the pixel having
25   the object label, and creates the object label image in which a different label is affixed for each mass.

Fig. 15A shows an example of an object label image 122 figured out by the noted position calculation unit 80, this example representing the status in which three objects 130, 132 and

5   134, e.g., three persons are obtained.

A label superposing picture 126 is then created by superposing as shown in Fig. 15C the object label picture 122 of Fig. 15A on the detected object picture 124 in which there exists an object

10   136 whose detailed picture in the form of the high-resolution partial picture has been acquired and which has been created through processings in the preceding frames as in Fig. 15B. An overlapping portion extracted picture 127 of Fig

15   16A is then extracted in which the degree of overlapping is extracted in each of the objects 130, 132 and 134 in the object label image 122 on the detected object 136 of the detected object picture 124.

20   As to this overlapping portion extracted image 127, the object 136 of the previous frame has an overlap 134 on the detected object 134 but the objects 130 and 132 do not have any overlap thereon. Thus, for the judgment of the degree of

25   overlapping, extracted as undetected objects are the objects 130 and 132 not more than the threshold value and having a sufficiently low degree of

overlapping.

In case of detection of a plurality of undetected objects 130 and 132 as in this example, one undetected object is selected which lies at

5   the outermost of the picture or which has a strongest possibility deviating from the picture from among the undetected objects. In the example of Fig. 15D, the object 130 at the leftmost of the picture is selected as the undetected noted

10   object.

Next obtained is a noted point desired to be shot as the high-resolution partial picture in the region of the noted object 130 selected, e.g., a position in the whole picture of a portion

15   of a face having maximal amounts of information in case of a person, the thus obtained result being output as a noted position 92 to the extracting position prediction detecting unit 84.

The noted position calculation unit 80

20   updates the detected object image in the detected object picture database 84 for use in the judgment processing in the next frame. More specifically, as shown in Fig. 15E, the noted position calculation unit 80 copies the noted object 130

25   detected as an undetected object and the detected object 134 judged to have a degree of overlapping of the overlap 140 not less than the threshold

value, to create an updated detected object picture 128 for the storage into the detected object picture database 85.

Then, using the position of the noted point obtained in the previous frame and using, when the target whose detailed picture is to be shot has already been observed, the position of the noted point in the previous frame and the history of the past motion, the extracting position prediction detecting unit 84 creates a motion model to predict the position to be observed in the next frame and determines the prediction position as extracting position data 94 for acquiring detailed pictures in the form of a high-resolution partial picture, for output.

In this case, the detailed picture of the noted object having the extracting position data 94 output can be acquired in the next frame, and hence the past motion history is deleted at this point of time.

On the contrary, when the target to create its detailed picture first appeared in the previous frame, there is no past motion history, and therefore the noted position data 92 calculated by the noted position calculation unit 80 is output intactly as an extracting position data 94 for acquiring the detailed picture.

        Although the position prediction method for
predicting the position in the motion model for
use in the extracting position prediction and the
position in the next frame can be any appropriate
5   method, it may be given by the following expression
using the position of the past position frame,
i.e., the last position, with the motion model
being a uniform rectilinear motion.

$$\begin{cases} \hat{x}_{i+1} = a_x x_i + b_x \\ \\ \hat{y}_{i+1} = a_y y_i + b_y \end{cases}$$

10

        where
        (x_i, y_i) represents a noted position in the
        current frame;

        $(\hat{x}_{i+1}, \hat{y}_{i+1})$ represents a predicted position to
15   which the noted position moves in the next frame:
and
        $\{a_x, a_y, b_x, b_y\}$ represents motion parameters.
        Finally, the background picture updating
unit 82 performs the updating processing in which
20   a new background picture is created using a
background portion picture 112 of Fig. 14D for
example acquired by the object region extraction
unit 76 and a background picture 108 of Fig. 14B
for example retained in the background picture

database 78. The updating processing

specifically includes using, for each pixel having

a value in the background portion image 112 of

Fig. 14D, its pixel value P1(x, 6) and a value

5    $P_2^t(x,y)$ of a pixel in the background picture

108 having the same coordinates to create a new

value $P_2^{t+1}(x,y)$ of the pixel in the background

picture 108.

Although this updating expression for use

10   in the creation of the pixel value can be any

appropriate updating expression, it may be given

as follows using a mixed coefficient β ($0 \leqq \beta \leqq 1$).

$$P_2^{t+1} = \beta P_1 + (1 - \beta)P_2^t$$

Figs. 16A and 16B are flowcharts showing the

15   procedure of processing effected by the image

processing unit 32 of Fig. 3. In Figs. 16A and

16B, a low-resolution whole picture data and a

background picture data from the database 72 are

first read at step S1, and difference picture data

20   between the two data for each pixel is created

at step S2, after which a label indicative of a

moving object is affixed to the pixel region having

a difference pixel value not less than a threshold

value to create an object portion picture at step

25   S3 whilst another label indicative of a non-moving

object is affixed to the pixel region having a

difference pixel value less than the threshold

value to create a background portion picture at step S4.

Then, at step S5, an object resulting in a mass of region is extracted through the contour search of the pixel value of the object portion picture, to differently perform labeling for each object. Then, at step S6, detected object picture in the previous frame acquired from the database is superposed on the object picture labeled at step S5 and, if the degree of overlapping is not more than a threshold value, then it is judged to be an undetected object.

Then, at step S7, it is checked whether a plurality of undetected objects exist, and if affirmative, then selection is made of an object having a strongest possibility deviating from the picture at step S8. Then, at step S9, a noted portion of the selected object, which may be a face portion in case of a person, is determined as the acquisition position of the detailed picture.

Next at step S10, the selected object and the detected object are copied to update the detected object picture for the next frame. Then at step S11, a motion model is created from the history of the object noted portion to predict the position of the next frame, and at step S12 the predicted

position is determined and output as the picture extraction portion.

It is to be noted when the noted object appears for the first time that the processings of steps S11 and S12 include intactly outputting the acquisition position determined at step S9. Then at step S13, the background picture of the previous frame retained in the background picture database 72 is updated using the background portion picture created in the previous frame. Such processings of the steps S1 to S13 are executed for each frame.

Fig. 17 is a block diagram of a second embodiment of a picture inputting apparatus in accordance with the present invention. This embodiment is characterized in that an image processing unit 32-1 further inputs high-resolution partial picture data in addition to the low-resolution whole picture data, to perform any image processing.

In Fig. 17, same as those in the above embodiment are the solid state image pickup device 10 having a pixel array, the low-resolution whole picture scanning unit 14, the high-resolution partial picture scanning unit 16, the timing generation unit 18, the switching unit 20, the switches 22-1 and 22-2, the low-resolution whole picture accumulation unit 24, whole picture data

transmission unit 26, the high-resolution partial picture accumulation unit 28 and the partial picture data transmission unit 30.

In addition to those, the second embodiment
5   is characterized in that an image processing unit 32-1 is provided which inputs low-resolution whole picture data from the low-resolution whole picture accumulation unit 24 as well as high-resolution partial picture data from the high-resolution
10   partial picture accumulation unit 28, thereby making it possible to perform any image processing including the processing for determining the extracting position of the high-resolution partial picture by using both the low-resolution
15   whole picture data and the high-resolution partial picture data or only the high-resolution partial picture data.

Fig. 18 is a block diagram of the functional configuration of the image processing unit 32-1
20   of Fig. 17. In Fig. 18, the image processing unit 32-1 is essentially the same as the image processing unit 32 of Fig. 13 in the first embodiment in that it includes the object region extraction unit 76, the background picture
25   database 78, the noted position calculation unit 80, the background picture updating unit 82, the extracting position prediction determining unit

84 and the detected object picture database 85, but the image processing unit 32-1 is characterized in that it additionally includes a false prediction detection unit which inputs high-resolution
5   partial picture data 138 for processing.

The false prediction detection unit 140 retains as predicted low-resolution whole picture data in the previous frame the low-resolution whole picture data in the vicinity of the noted position
10 calculated by the noted position calculation unit 80 prior to the execution of prediction by the extracting position prediction determining unit 84, and compares this predicted low-resolution whole picture data with the high-resolution
15 partial picture data 138 acquired in the previous frame.

If there is a great difference between the two as a result of comparison of the predicted low-resolution picture in the vicinity of the noted
20 position of the previous frame with the high-resolution partial picture in the previous frame, then it is judged that the prediction of position for acquiring a high-resolution partial picture of the noted portion is false, and the
25 noted position calculation unit 80 is posted on a non-acquisition 142 of the detailed picture which is the high-resolution partial picture of the noted

object so that the status of the noted position calculation unit 80 is changed into a status where the noted object calculated in the previous frame is again extractable.

5   That is, the object picture of the noted object calculated in the previous frame is deleted from the detected object pictures updated in the previous frame in the detected object picture database 85 provided in the noted position

10   calculation unit 80, to thereby make a setting such that a high-resolution partial picture of the noted object can further be acquired.

More concretely, if an updated detected object image 128 as shown in Fig. 15E is retained

15   in the previous frame, then since an object 130 is a noted object, the object label corresponding to the noted object 130 is removed to achieve a change into a detected object picture 124 as shown in Fig. 14B.

20   For this reason, when the false prediction takes place without the high-resolution partial picture being obtained of the noted portion associated therewith, it is possible to again acquire the high-resolution partial picture of

25   the same noted object through the same processing as in the previous frame.

Figs. 19A and 19B are flowcharts of the

procedure of the image processing in Fig. 18. In Figs. 19A and 19B, the processes of steps S1 to S5 are the same as those of the flowchart of Figs. 16A and 16B, but at step S6 which follows, false

5   prediction detection processing is newly provided.

Steps S7 to S10 which follow are the same as processes of the steps S6 to S9 of Figs. 16A and 16B, but differs therefrom in that the

10   low-resolution picture in the vicinity of the noted position selected at step S10 is selected for the false prediction detection in the next frame. The remaining steps S12 to S15 are the same as the processes of the steps S10 to S13 of Figs. 16A

15   and 16B.

Fig. 20 is a flowchart of the detailed procedure of the false prediction detection processing of step S6 in Figs. 19A and 19B. In Fig. 20, the false prediction detection processing

20   includes reading in a high-resolution partial picture at step S1 and reading for comparison predicted low-resolution picture data in the vicinity of the noted position prior to the prediction of the position by the motion capacity

25   retained in the previous frame at step S2.

If it is judged at step S3 as a result of this comparison that the degree of matching between

the two becomes equal to or less than a predetermined threshold value, resulting in a great difference, then the noted object in the previous frame is deleted from the detected object

5   picture at step S4, after which the procedure returns to step S7 in which in the following processings, the extracting position is again determined of the noted object in the previous frame such that a high-resolution partial picture

10   can be acquired.

       Figs. 21A and 21B are block diagrams of another embodiment of the present invention enabling any image processing to be performed by transferring to an external image processor the

15   low-resolution whole picture and the high-resolution partial picture obtained by the image inputting processing of the present invention.

       In Figs. 21A and 21B, a picture transmission

20   unit 146 is provided for the picture inputting apparatus 100 of the present invention shown in the embodiment of Fig. 1 or Fig. 17. The picture transmission unit 146 includes a D/A converter 156 for converting low-resolution whole picture

25   data output from the picture inputting apparatus 100 into an analog picture signal such as NTSC, for example, and a picture transmitter 158 for

transmitting the thus obtained analog picture signal to a transmission line 145.

The picture transmission unit 146 further includes a D/A converter 160 for converting

5 high-resolution partial picture data into an analog picture signal such as NTSC, and a picture transmitter 162 for transmitting the thus obtained analog signal to the transmission line 145.

An image processor 150 disposed at a remote

10 external position is connected via a picture receiving unit 148 to the transmission line 145 from the picture inputting apparatus 100. The picture receiving unit 148 is provided with picture receivers 164 and 168, and A/D converters 166 and

15 170.

The picture receiver 164 receives an analog picture signal of a low-resolution whole picture transmitted via the transmission line 145 from the picture inputting apparatus 100 and converts

20 the analog picture signal by the A/D converter 166 into digital data for the input to the image processor 150. The picture receiver 168 receives an analog picture signal of a high-resolution partial picture transmitted via the transmission

25 line 145 from the picture inputting apparatus 100 and converts the analog picture signal by the A/D converter 170 into digital data for the input to

the image processor 150.

This enables the image processor 150 to receive at a frame rate not less than the video rate of 30 fsp a low-resolution whole picture and a high-resolution partial picture acquired by the picture inputting apparatus of the present invention and to execute in a distributed manner the functions of, e.g., performing specific recognition processing of the detailed picture obtained as the high-resolution partial picture using the low-resolution whole picture and the high-resolution partial picture of the noted point acquired by automatic tracking of the picture inputting apparatus 100 of the present invention.

The picture inputting apparatus 100 is associated with a data transmission unit 152 which includes a data transmitter 172 and a data receiver 174. Correspondingly, the external image processor 150 is also associated with a data transmission unit 154 which includes a data receiver 176 and a data transmitter 178.

The data transmitter 172 and the data receiver 174 transmit via the transmission line 145 to the external image processor 150 the positional information on the extracting position of the high-resolution partial picture determined by the image processing unit 32 of Fig. 1 or the

image processing unit 32-1 of Fig. 13 disposed on the picture inputting apparatus 100.

The data transmitter 178 and the data receiver 176 transmit instructive information on

5   the extracting position of the high-resolution partial picture from the external image processor 150 via the transmission line 145 to the image inputting apparatus 100 of the present invention, to thereby impart an external instruction to the

10   picture inputting apparatus 100.

According to the embodiment of Figs. 21A and 21B, it is possible to perform any recognition processing using two pictures in a function isolated manner by transmitting the whole picture

15   and the partial picture from the picture inputting apparatus of the present invention 100 to the external image processor 150. Depending on the complexity of the image processing, it is possible to share the processing by the picture inputting

20   apparatus 100 of the present invention and by a single or a plurality of external image processor(s), and to constitute an image processing system having any scale in conformity with the complicated processing.

25   Since the picture information transmitted from the picture inputting apparatus 100 to the image processor 150 is converted into an analog

signal for transmission, it is possible to extend the transmission distance therebetween and to constitute a system in a distributed environment where their respective image processors are placed

5   at positionally remote sites.

Fig. 22 shows another embodiment of a solid state image pickup device used in the embodiment of Fig. 1 or Fig. 13. This embodiment is characterized in that the low-resolution whole

10   picture is created through thinning-out processing of the pixel array.

In Fig. 22, similar to the embodiment of Fig. 2, a pixel array 10-1 consists of a plurality of execution cells in $N_1 \times N_2$ matrix of pixels arranged

15   at a high density. All the filters are removed which have been provided for each group cell of $m_1 \times m_2$ in matrix in order to obtain the low-resolution pixel value in the embodiment of Fig. 2, and correspondingly the structure of the

20   photo-receptive cell shown in Fig. 23 is employed.

In the structure of the photo-receptive cell of Fig. 23, the photo-receptive cell 52 is associated with a row selection line 54 and a column selection line 56, with only a single output line

25   60 extending from the photo-receptive cell 52 for the individual pixel output.

The low-resolution whole picture scanning

unit 14 of Fig. 1 and Fig. 13 for effecting readout

scanning of a low-resolution whole picture on such

a solid state image pickup device 10-1 performs

address designation for the row selection circuit

5   36 with a row addressing signal 44 every n_1 pixels

and performs address designation for the column

selection circuit 38 resulting in column direction

with a column addressing signal 46 every n_2 pixels,

to thereby enable $m_1 \times m_2$ pixels of low-resolution

10   whole picture to be read out from the matrix of

$N_1 \times N_2$ pixels.

The thinning-out processing of this

embodiment has a strong possibility to cause

aliasing in which the picture high-frequency

15   components create false information in the

low-resolution pictures.   Therefore, by limiting

the target of observation by use of the solid state

image pickup device 10-1 of this embodiment to

the observation target whose whole picture has

20   a relatively low spatial frequency, it is possible

to suppress the aliasing problem in the

low-resolution image arising from the pixel

thinning-out processing.   ·

Although the above description of the

25   embodiments has been made mainly of the functions

of the picture inputting apparatus intended for

the image processing, it is natural that the image

inputting apparatus of the present invention could
be used as a picture sensor for monitoring and
applied to a monitoring system in which a
low-resolution whole picture in the form of a
5   time-varying image capable of being acquired at
a rate equal to or higher than the video rate and
a high-resolution partial picture obtained by
automatic determination of a noted portion are
displayed separately on a monitor such that a
10   person can directly monitor them.

The present invention could be applied to
a system in which the low-resolution whole picture
and the high-resolution partial picture obtained
in the present invention are directly transmitted
15   by a video transmission system having a VTR or
a hard disk.

The pixel sizes of low resolution and high
resolution in the above embodiments are merely
relative ones, and hence the relationship between
20   the low resolution and the high resolution could
be established by an appropriate standard if
necessary.

Although the above embodiments employ for
output the same pixel size of the low-resolution
25   whole picture and high-resolution partial picture
acquired by the picture inputting apparatus of
the present invention, the pixel size of the

high-resolution partial picture could be further
enlarged insofar as its rate does not fall below
the video rate of 30 fps, or alternatively it could
be a smaller size than the pixel size of the
5   low-resolution whole picture.

The present invention is not limited to the
above embodiments but includes any variants
without impairing its objects and advantages.
Furthermore, the present invention is not
10   restricted by numerical values indicated in the
above embodiments.

As set forth hereinabove, according to the
present invention, the whole scene to be observed
can be acquired as a low-resolution whole picture,
15   with only the partial noted points therewithin
being acquired in the form of detailed pictures
as high-resolution partial pictures. In cases
where for example the low-resolution whole picture
and the high-resolution partial picture have the
20   same size, even though the resolution of the
high-resolution partial pictures is extremely
high, the total amount of information of the two
pictures can be the amount of information for two
low-resolution whole pictures, whereby the
25   low-resolution whole picture and the
high-resolution partial picture (detailed
picture) can be acquired at the same time and at

a frame rate equal to or greater than the video rate.

The picture inputting apparatus of the present invention enables noted portions acquired as detailed pictures in the form of high-resolution partial pictures to automatically and rapidly selectively be determined depending on the contents of the low-resolution whole picture through the execution of any image processing program in the image processing unit included in the apparatus.

With the scene being an object to be processed where the object moves or varies with time, use of this function enables both the image processing in which quite different points in the whole shooting region are determined as positions acquiring high-resolution information for each frame depending on the variance with time and the shooting of the high-resolution pictures at the quite different shooting positions for each frame through this selection.

Satisfactory images for image processing using the low-resolution whole pictures can be obtained without the picture high-frequency components causing any aliasing which may generate fault information in the low-resolution pictures, since low-resolution pictures are generated

through the local averaging processing in which
for the pixel array of the solid state image pickup
device having a high-density pixel arrangement,
a filter is provided for each set of pixels
5   segmented into a matrix pixel count for the
generation of a low-resolution picture, so-call
for each group cell to output as a new pixel value
the sum total or the mean values of a plurality
of pixel values.

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